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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/662,522	09/16/2003	Anthony Dip	241482US6YA	1707

22850 7590 10/28/2005

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EXAMINER	
MARKHAM, WESLEY D	
ART UNIT	**PAPER NUMBER**
1762	

DATE MAILED: 10/28/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/662,522	DIP ET AL.	
	Examiner	Art Unit	
	Wesley D. Markham	1762	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *17 October 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-77* is/are pending in the application.

4a) Of the above claim(s) *14-19,39-50,53-57 and 65-77* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-13,20-38,51,52 and 58-64* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *16 September 2003 and 09 February 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☒ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Applicant's election with traverse of (I) Group I, Claims 1 – 64, drawn to a method of forming a metal containing film on a substrate, (II) the first species of Group A (i.e., using an oxidizing reactant to form a metal oxide film), and (III) the last species of Group B (i.e., the metal containing precursor comprises a metal alkylamide) in the reply filed on 10/17/2005 is acknowledged. The traversal is on the ground(s) that search and examination of the entire application would not place a serious burden on the examiner because the claims would have to be searched in a handful of sub-classes, and electronic searching allows the examiner to search a large number of subclasses without substantial additional effort. This is not found persuasive because a serious burden on the examiner in searching and examining the entire application exists for the following reasons: (1) the class/subclass search required for the elected invention / species (i.e., a method of making a metal oxide film) is significantly different from the class/subclass search required for the non-elected inventions / species (i.e., a method of making a metal, metal nitride, metal silicate, metal oxynitride, or nitrogen-containing metal silicate film; a computer readable medium; and an apparatus); (2) the electronic database text search strategy for the elected invention / species is significantly different from the electronic database text search strategy for the non-elected inventions / species; and (3) significantly different patentability issues arise during the simultaneous prosecution of the different statutory classes of inventions claimed by the applicant (e.g., method,

apparatus, and product). The requirement is still deemed proper and is therefore made FINAL.

2. As such, Claims 14 – 19, 39 – 50, 53 – 57, and 65 – 77 are withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected invention / species, there being no allowable generic or linking claim.

Oath/Declaration

3. The oath or declaration is defective. A new oath or declaration in compliance with 37 CFR 1.67(a) identifying this application by application number and filing date is required. See MPEP §§ 602.01 and 602.02.The oath or declaration is defective because the specification to which the oath or declaration is directed has not been adequately identified. See MPEP § 602. Specifically, the declaration incorrectly states that the instant application was filed on 9/15/2003 when the correct filing date is 9/16/2003.

Drawings

4. The drawings filed on 9/16/2003 and 2/9/2004 (i.e., 2 replacement sheets depicting Figures 8 and 9) are acknowledged and approved by the examiner.

Claim Objections

5. Claims 61 and 62 are objected to because of the following informalities: The claims appear to contain typographical errors. Specifically, the claims both require that "the plurality of substrates" have a specific thickness and WIW uniformity value.

However, it is clear from the specification of the instant application that it is the HfO_2 films deposited on the plurality of substrates that have the aforementioned thickness(es) and WIW uniformity value(s) (see, for example, paragraph [0060]), not the substrates themselves. Claims 61 and 62 have been interpreted in accordance with the specification, and the applicant is suggested to amend Claims 61 and 62 to accurately reflect the applicant's invention. Appropriate correction is required.

Claim Observations

6. The examiner has broadly but reasonably interpreted a "batch type processing system" as recited in independent Claim 1 to be inclusive of any system capable of processing one or more substrates.

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

8. Claims 1 – 4, 6, 11 – 13, 20 – 23, 27, 28, 31, 34 – 36, 51, and 52 are rejected under 35 U.S.C. 102(b) as being anticipated by Ono et al. (USPN 6,420,279).

9. Regarding independent **Claim 1**, Ono teaches a method of forming a metal-containing film (e.g., a high-k hafnium and/or zirconium oxide film) on a substrate, the method comprising providing a substrate in a process chamber of a batch type processing system, heating the substrate, flowing a pulse of a metal-containing precursor (e.g., a Hf or Zr nitrate) in the process chamber, flowing a pulse of a reactant gas (e.g., an oxidizing or hydrating gas) in the process chamber, and repeating the flowing processes until a metal-containing film with desired film properties is formed on the substrate (Abstract, Figures 1 and 2, Cols.1 – 5). Ono also teaches forming a HfO_2 and/or ZrO_2 film (**Claims 2 and 3**) (Abstract, Col.2, lines 18 – 19); flowing a purge gas in the chamber when the other gases are not flowing (**Claims 4 and 6**) (Figures 1 and 2; Col.3, lines 36 – 39 and 49 – 51); the reactant gas is an oxygen-containing, oxidizing gas such as H_2O (**Claims 11 – 13**) (Col.3, lines 40 – 48); a silicon semiconductor substrate (**Claims 20 and 21**) (Col.3, lines 1 – 18); providing a substrate containing an interfacial film selected from an oxide film, a nitride film, an oxynitride film, or mixtures thereof (**Claim 22**) (Col.2, lines 9 – 14, Col.3, lines 8 – 12); providing "a semiconductor substrate" (i.e., a batch of a single substrate, which is "about 100 substrates or less") in the chamber (**Claim 23**) (Col.2, lines 65 – 67); the claimed heating temperature(s) (**Claims 27 and 28**) (Col.3, lines 13 – 18 and 59 – 67, Col.4, lines 1 – 13); the claimed chamber pressure (**Claim 31**) (Col.3, line 61); the claimed film thickness (**Claims 34 – 36**) (Col.3, line

66 – Col.4, line 13); using a self-limiting process to form the film (**Claim 51**) (Col.3, line 52 – Col.4, line 13); and heating the substrate to a single temperature of, for example, 180° C or 170° C during the deposition process (i.e., heating the substrate under isothermal heating conditions) (**Claim 52**) (Col.3, line 59 – Col.4, line 13).

10. Claims 1 – 4, 6, 7, 11 – 13, 20, 23, 25 – 27, 31 – 33, 51, and 52 are rejected under 35 U.S.C. 102(a) or (e) as being anticipated by Lim (USPN 6,465,371).

11. Regarding independent **Claim 1**, Lim teaches a method of forming a metal-containing film (e.g., a high-k zirconium oxide film) on a substrate, the method comprising providing a substrate in a process chamber of a batch type processing system, heating the substrate, flowing a pulse of a metal-containing precursor (e.g., a Zr alkoxide) in the process chamber, flowing a pulse of a reactant gas (e.g., an oxidizing gas) in the process chamber, and repeating the flowing processes until a metal-containing film with desired film properties is formed on the substrate (Abstract, Figure 1, Cols.1 – 4). Lim also teaches forming a ZrO_2 film (**Claims 2 and 3**) (Abstract, Col.1, line 24); flowing a purge gas in the chamber when the other gases are not flowing (**Claims 4 and 6**) (Col.2, lines 35 – 40 and 49 – 54); the claimed purge gas pulse duration (**Claim 7**) (Col.2, lines 35 – 40 and 49 – 54); the reactant gas is an oxygen-containing, oxidizing gas such as H_2O, O_2, N_2O, O_3, etc. (**Claims 11 – 13**) (Col.2, lines 41 – 48); a semiconductor substrate (**Claim 20**) (Col.1, lines 59 – 63); providing "a wafer" (i.e., a batch of a single substrate, which is "about 100 substrates or less") in the chamber (**Claim 23**) (Col.2, line 26); the

claimed metal containing precursor and reactant gas pulse durations (**Claims 25 and 26**) (Col.2, lines 23 – 54); the claimed heating temperature (**Claim 27**) (Col.2, lines 31 – 34); the claimed chamber pressure(s) (**Claims 31 – 33**) (Col.2, lines 58 – 62); using a self-limiting process to form the film (**Claim 51**) (Col.2, lines 23 – 62); and heating the substrate to "a temperature" during the deposition process (i.e., heating the substrate under isothermal heating conditions) (**Claim 52**) (Col.2, lines 30 – 34).

12. Claims 1, 4, 6 – 8, 10, 11, 20 – 23, 27, 28, 31 – 33, 38, and 51 are rejected under 35 U.S.C. 102(a) or (e) as being anticipated by Elers et al. (USPN 6,475,276).
13. Regarding independent **Claim 1**, Elers teaches a method of forming a metal-containing film (e.g., an elemental metal film) on a substrate, the method comprising providing a substrate in a process chamber of a batch type processing system, heating the substrate, flowing a pulse of a metal-containing precursor in the process chamber, flowing a pulse of a reactant gas (e.g., a boron-containing reducing gas) in the process chamber, and repeating the flowing processes until a metal-containing film with desired film properties is formed on the substrate (Abstract, Figure 1, Cols.1 – 8). Elers also teaches flowing a purge gas in the chamber when the other gases are not flowing (**Claims 4 and 6**) (Figure 1; Cols.3 – 4); the claimed purge gas pulse duration (**Claim 7**) (Example 1); flowing the metal-containing precursor and reactant gas with a carrier gas (**Claims 8 and 10**) (Col.3, line 65 – Col.4, line 28); the reactant gas is a reducing gas (**Claim 11**) (Col.3, line 56); the claimed substrate(s)

(**Claims 20 and 21**) (Col.5, lines 3 – 16); providing a substrate containing an interfacial film selected from an oxide film, a nitride film, an oxynitride film, or mixtures thereof (**Claim 22**) (Col.5, line 3 – 16); providing a batch of two substrates in the chamber (**Claim 23**) (Example 1); the claimed heating temperature(s) (**Claims 27 and 28**) (Col.4, lines 40 – 43); the claimed chamber pressure(s) (**Claims 31 – 33**) (Col.4, lines 29 – 32); further comprising depositing the claimed electrode film(s) (**Claim 38**) (Col.5, lines 3 – 36); and using a self-limiting process to form the film (**Claim 51**) (Col.4, lines 49 – 62).

Claim Rejections - 35 USC § 103

14. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

15. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

16. Claims 5, 7, 25, 26, and 30 – 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of Chang et al. (US 2003/0031793) and Kaloyeros et al. (USPN 6,346,477).

17. Ono et al. teaches all the limitations of **Claims 5, 7, 25, 26, and 30 – 33** as set forth above in paragraph 9, except for the claimed gas flow rate(s), pulse duration(s), and chamber pressure(s). However, Chang et al. (paragraph [0041]) and Kaloyeros et al. (Cols.8 – 9) teach that process parameters such as gas flow rate, pulse duration, temperature, and chamber pressure are result / effective variables that are interrelated and influenced by the nature of the reactants used in the ALD process. As such, it would have been obvious to one of ordinary skill in the art to have optimized the aforementioned process conditions as result / effective variables though routine experimentation based on the specific ALD process being carried out (e.g., the ALD reactor used, the reactants used, etc.).

18. Claims 8 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of Raaijmakers et al. (US 2001/0054769).

19. Ono et al. teaches all the limitations of **Claims 8 and 10** as set forth above in paragraph 9, except for using a carrier gas with the metal containing precursor gas and the reactant gas. However, Raaijmakers et al. teaches using a carrier gas along with the precursor and reactant gas(es) in an ALD process (paragraphs [0079] – [0103]), and it would have been obvious to one of ordinary skill in the art to use such

a carrier gas in the process of Ono in order to aid in the transportation of the precursor and reactant gases into the chamber (i.e., to provide the benefit of a stable and uniform gas flow rate).

20. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of Raaijmakers et al., in further view of Chang et al. (US 2003/0031793) and Kaloyeros et al. (USPN 6,346,477).

21. The combination of Ono and Raaijmakers teaches all the limitations of **Claim 9** as set forth above in paragraph 19, except for the claimed gas flow rate. However, optimizing various gas flow rates in an ALD process such as that of Ono would have been obvious to one of ordinary skill in the art in view of the teachings of Chang et al. and Kaloyeros et al. (see paragraph 17 above).

22. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of Hyun et al. (USPN 6,042,652).

23. Alternatively to the reasoning presented above, Ono et al. teaches all the limitations of **Claim 23** as set forth above in paragraph 9, except for providing a batch of about 100 substrates or less. However, Hyun teaches an ALD apparatus capable of forming a film on a plurality of substrates (e.g., 4, which is less than 100) in a single batch (Figures 3 and 4; Cols.1 – 8). Therefore, it would have been obvious to one of ordinary skill in the art to do so in the context of the ALD process of Ono in order to

reap the advantage of increasing process throughput (i.e., due to processing a plurality of substrates at the same time).

24. Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of Suntola et al. (USPN 6,572,705).

25. Ono et al. teaches all the limitations of **Claim 24** as set forth above in paragraph 9, except for providing a substrate with a diameter greater than about 195 mm. However, Suntola et al. teaches that ALD successfully deposits films on large substrates (e.g., 300 mm in diameter) (Col.11, line 20), and it would have been obvious to one of ordinary skill in the art to do so in order to deposit ALD films on as large a substrate as possible, thereby improving process throughput.

26. Claim 29 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of Paranjpe (US 2003/0134038).

27. Ono et al. teaches all the limitations of **Claim 29** as set forth above in paragraph 9, except for forming the metal-containing precursor by flowing a metal-containing precursor liquid into a vaporizer at a flow rate between about 0.05 ccm and 1 ccm. Specifically, Ono et al. is silent regarding how the metal containing precursors (e.g., Zr or Hf nitrates) are converted to a vapor / gaseous phase suitable for ALD. Paranjpe teaches delivering a metal containing precursor pulse by flowing a precursor liquid into a vaporizer (paragraph [0068]). The system taught by Paranjpe has the following advantages: delivering a high maximum flow rate to the reactor,

reducing waste, and minimizing particle generation. Therefore, it would have been obvious to one of ordinary skill in the art to deliver the precursors of Ono in the manner taught by Paranjpe (i.e., to a vaporizer and then to the chamber) in order to reap the advantages discussed above. The liquid flow rate to the vaporizer would, of course, depend on the desired precursor vapor flow rate into the ALD chamber.

28. Claim 37 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of Jeon (USPN 6,607,973).

29. Ono et al. teaches all the limitations of **Claim 37** as set forth above in paragraph 9, except for the claimed annealing temperature of between about 150° C and about 1000° C. Specifically, Ono et al. teaches annealing the film to condition the film and any interfaces between the layers (Col.5, lines 8 – 10) but is silent regarding the annealing temperature. Jeon teaches annealing a high-k dielectric layer (e.g., HfO_2, which is a material taught by Ono) at the claimed temperature (abstract, Col.4, lines 56 – 59), and it would have been obvious to one of ordinary skill in the art to do so in order to condition the film and any interfaces between the layers, as desired by Ono, at a suitable annealing temperature.

30. Claim 38 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al.

31. Ono et al. teaches all the limitations of **Claim 38** as set forth above in paragraph 9, except for depositing an electrode film comprising at least one of the claimed materials. However, Ono et al. does teach that the claimed ALD method is generally

applicable to IC fabrication processes (Col.1, lines 7 – 10) and is used in conjunction with a variety of substrates / surfaces (Col.3, lines 6 – 13). Therefore, it would have been obvious to one of ordinary skill in the art to utilize the ALD method of Ono et al. to deposit a high-k dielectric material in conjunction with any other conventionally-known IC fabrication process, including depositing the well-known electrode films claimed by the applicant, with the reasonable expectation of successfully and advantageously obtaining the benefits taught by Ono et al. (e.g., easily depositing a pure, high-k material) in the context of IC fabrication, which requires depositing a variety of different films (e.g., electrodes, gates, barrier layers, dielectrics, etc.) to form a finished device.

32. Claim 52 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of Bondestam et al. (US 2002/0157611) or Maes (USPN 6,818,517).

33. As an alternative to the reasoning presented above, Ono teaches all the limitations of **Claim 52** as set forth above in paragraph 9, except for a method comprising heating the substrate under isothermal heating conditions. However, Bondestam et al. teaches that, in the art of ALD, the substrate and chamber wall temperature(s) are important variables to control in order to insure that self-limited ALD takes place on the substrate, and the chamber wall temperature is the same as the substrate temperature (i.e., the heating is isothermal) (Abstract, Figures 1 – 5, paragraphs [0018] – [0033]). Therefore, it would have been obvious to one of ordinary skill in the art to heat the substrate to the desired temperature under isothermal conditions in

the ALD process of Ono in order to insure that self-limited ALD takes place on the substrate and to avoid decomposition and/or condensation of the ALD reactants, which would occur if portions of the substrate / chamber are outside of the ALD temperature window. Additionally, Maes teaches that an ALD process is preferably carried out under isothermal conditions (Abstract), and it would have been obvious to one of ordinary skill in the art to do so in the ALD process of Ono et al. because such heating is described as preferred by Maes.

34. Claims 58 – 60 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of Leskela et al. (US 2002/0182320).

35. Ono teaches all the limitations of **Claims 58 – 60** as set forth above in paragraph 9, except for the claimed Hf or Zr alkylamide precursors. However, Leskela et al. teaches that the claimed alkylamide precursors are effective for producing metal containing (e.g., zirconium and hafnium) films by ALD, and it would have been obvious to one of ordinary skill in the art to use such precursors as opposed to the nitrate precursors taught by Ono with the reasonable expectation of success and obtaining similar results (i.e., successfully depositing the Zr- or Hf-containing film by ALD, regardless of whether a nitrate or an alkylamide is used as the precursor).

36. Claims 61 and 62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of Hyun et al. and Cook et al. (US 2003/0049372).

37. Ono teaches all the limitations of **Claims 61 and 62** as set forth above in paragraph 9, except for providing a plurality of substrates in the process chamber and the claimed WIW uniformity (e.g., about 10% to about 15%). However, it would have been obvious to one of ordinary skill in the art to provide a plurality of substrates in view of the teachings of Hyun (see paragraph 23 above). Additionally, Cook et al. teaches that optimizing an ALD process results in excellent WIW uniformity (see entire document), and it would have been obvious to one of ordinary skill in the art to optimize the batch ALD process of the combination of Ono and Hyun in order to maximize the WIW uniformity (as taught by Cook et al.), thereby insuring a high quality product.

38. Claims 63 and 64 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of Hyun et al. and Bondestam et al.

39. Ono teaches all the limitations of **Claims 63 and 64** as set forth above in paragraph 9, except for providing a plurality of substrates in the process chamber and heating within a temperature range at which film deposition rate is independent of temperature. However, it would have been obvious to one of ordinary skill in the art to provide a plurality of substrates in view of the teachings of Hyun (see paragraph 23 above). Additionally, Ono teaches depositing a hafnium oxide film by ALD at the claimed temperature (Col.3, line 59 – Col.4, line 13). Further, Bondestam et al. teaches that the temperature profile of an ALD process should be optimized so that the substrate is within the ALD window (i.e., a temperature range at which deposition

rate is independent of temperature – see figures), thereby insuring that only ALD (not decomposition, condensation, etc.) takes place on the substrate (see entire document). As such, it would have been obvious to one of ordinary skill in the art to optimize the temperature of the substrates in the process of the combination of Ono and Hyun so that they are within the ALD temperature window, thereby insuring that no undesired deposition takes place on the substrate surface (i.e., only self-limited ALD takes place).

40. Claim 29 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lim in view of Paranjpe (US 2003/0134038).

41. Lim teaches all the limitations of **Claim 29** as set forth above in paragraph 11, except for forming the metal-containing precursor by flowing a metal-containing precursor liquid into a vaporizer at a flow rate between about 0.05 ccm and 1 ccm. Specifically, Lim is silent regarding how the metal containing precursor (e.g., Zr alkoxide(s)) is converted to a vapor / gaseous phase suitable for ALD. Paranjpe teaches delivering a metal containing precursor pulse by flowing a precursor liquid into a vaporizer (paragraph [0068]). The system taught by Paranjpe has the following advantages: delivering a high maximum flow rate to the reactor, reducing waste, and minimizing particle generation. Therefore, it would have been obvious to one of ordinary skill in the art to deliver the precursor of Lim in the manner taught by Paranjpe (i.e., to a vaporizer and then to the chamber) in order to reap the

advantages discussed above. The liquid flow rate to the vaporizer would, of course, depend on the desired precursor vapor flow rate into the ALD chamber.

42. Claim 52 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lim in view of Maes (USPN 6,818,517).

43. As an alternative to the reasoning presented above, Lim teaches all the limitations of **Claim 52** as set forth above in paragraph 11, except for a method comprising heating the substrate under isothermal heating conditions. However, Maes teaches that an ALD process is preferably carried out under isothermal conditions (Abstract), and it would have been obvious to one of ordinary skill in the art to do so in the ALD process of Lim because such heating is described as preferred by Maes.

44. Claims 58 – 60 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lim in view of Leskela et al. (US 2002/0182320).

45. Lim teaches all the limitations of **Claims 58 – 60** as set forth above in paragraph 11, except for the claimed Hf or Zr alkylamide precursors. However, Leskela et al. teaches that the claimed alkylamide precursors are effective for producing metal containing (e.g., zirconium) films by ALD, and it would have been obvious to one of ordinary skill in the art to use such precursors as opposed to the alkoxide precursors taught by Lim with the reasonable expectation of success and obtaining similar results (i.e., successfully depositing the Zr-containing film by ALD, regardless of whether a Zr alkoxide or a Zr alkylamide is used as the precursor).

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Sandhu et al. (US 2004/0065258), Kim et al. (US 2003/0013320), and Doering et al. (USPN 6,174,377) are cited as further evidence that a process of depositing a film by ALD on a plurality of substrates simultaneously in a batch type processing apparatus was well-known at the time of the applicant's invention.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wesley D. Markham whose telephone number is (571) 272-1422. The examiner can normally be reached on Monday - Friday, 8:00 AM to 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tim Meeks can be reached on (571) 272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Wesley D Markham

WDM

WDM

Examiner
Art Unit 1762

TIMOTHY MEEKS
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